What is It and How Did We Get Here?

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Sagittal Balance

Concept:
State of spine curvature in sagittal plane which supports equilibrium (force balance)
- efficient stability.
Optimal Spinal Balance
- Head over feet
- Shoulders over feet
- Pelvis over feet

"Cone of Economy" by Jean Dubousset
Ideal spinal alignment allows a standing posture with minimal muscular energy.
Center of the cone is ergonomically favorable.
Outside the edge of the cone requires greater energy use and leads to extreme muscular demand.

THE ROAD TO UNDERSTANDING SAGITTAL BALANCE

Recognition of Flat Back Syndrome 1980’s
Sagittal Malalignment
Early 1980’s A-P osteotomies

Road to Proper Sagittal Alignment was Foggy

The Pelvic Vertebrae

The Pelvis is the Base of the Spine
Jean Dubousset - 1984
Pelvic Incidence

- Duval-Beaupeure (1992)
- Legaye (1998)

- Definition
  - Angle between the perpendicular at the midpoint of the sacral plate and the line connecting this point to the femoral head axis
  - Everyone's pelvis is different. PI determines relationship to rest of spine

Pelvic Incidence

- A morphological parameter
- Stays constant throughout adult life
- Not affected by patient position
- Rocking your pelvis backwards doesn’t change it

Lumbar Lordosis

- Normal lumbar lordosis is within the range of 63° ± 15°
- Relates to pelvic incidence
  - PI - LL = ± 9°
- At least 2/3 of LL is at L4-S1
So What is The Connection to Lordosis?

Normal Sagittal Alignment
Pelvic Incidence and Lordosis

Large PI
Horizontal sacrum
Marked, long lordosis

Small PI
Vertical sacrum
Flat lordosis

Pragmatic Estimate:
\[ LL = PI \pm 10^\circ \]

Pelvic Tilt

- Angle between the vertical and line drawn from mid-sacral endplate to femoral heads
- Normal pelvic tilt is **less than 20 degrees**
- Compensatory mechanism to reduce positive balance
Compensation for Loss of Sagittal Balance

SO WHAT??

Pelvic Parameters

Multi-linear models
- ODI = 0.2106 * PT - 13.719
- ODI = 1.5563 * SVA - 16.293
- ODI = 0.4379 * PI - LL - 6.0827
- Thresholds for Disability
  - (ODI>40)
  - PI - LL > 11°
  - SVA > 47mm
  - PT > 20°

Global alignment
- + : SVA within 15°
  - moderate 10-20°
  - severe >20°

Pelvic Tilt
- + : PT 20-30°
  - + : PT > 30°
Alignment Matters

- Preservation/restoration of lumbar lordosis is crucial to the success (clinical outcome: pain/disability) of any lumbar fusion.
- Sagittal balance is directly correlated to clinical outcome: avoid sagittal decompensation.1,2
- If the clinically relevant radiographic parameters are not achieved the patient runs a 10x higher risk of reoperation.2


Impact of Sagittal Balance

- Adverse health outcomes are highly correlated with positive sagittal balance
- Sagittal balance assessment should be a critical consideration during patient evaluation and surgical planning
Goals for Patient Outcomes

Sagittal Balance Restoration aims to improve patient quality of life:
- Resolve pain and dysfunction
- Restore horizontal gaze
- Ability to make eye contact
- Provide energy conservation
- Movement requires less muscle engagement and fatigue
- Arrest evolution of deformity

Goals for Sagittal Balance

Alignment Objectives
1. PI TL < 10°
2. PT < 20°
3. SVA < 5 cm